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Analysis of Transportation Cost Implications of Logistics Networks of Nigerian Shipyards

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ABSTRACT

The study analyzed the transportation cost implications of the logistics networks of shipbuilding and repair yards in Nigeria using the shipyards in onne, River State shipbuilding and repair clusters. The objectives of the study was among other things to determine determinant the input materials types that form the determinant inventory maintained by the shipyard over the years, evaluate the annual transportation cost implications of shipping per unit load of inventory from the identified supply sources/inbound logistics networks and to compare the transportation cost of shipping inventory from alternative/multiples sources on the inbound logistics network of the shipyard. The study used a mixed method comprised of survey which involved the use of questionnaire as instrument for data collection, and the use of secondary data. The analytical methods of major component data analysis, difference of means statistical method and the Transportation-Cost Average-Annual-Orders Relationship Analysis (TARA) were used to analyze the data obtained. It was found that about three (3) input materials/inventory types with Eigen values greater than or equal to 1 are the significant component inventory types which the shipyard need to maintain higher inventories of in the store in order to limit inventory carrying cost and adopt a favourable logistics and materials management strategy. Marine diesel engines components (MDEC), electrical electronic navigation systems components (EENSC) and other mechanical parts, boiler mountings components (MPBC); each with respective Eigen values of 3.840, 1.568 and 1.230. The result also shows that the inventory items which have less average annual order frequencies such as PSSC, EENSC, each with average order frequency of 4.4 and 4.8 respectively, etc imposed the greatest annual transportation cost while those with higher annual order frequencies such as MFPF, BPTM with respective average order frequencies of 6.2 and 6.2, etc imposed the least annual transportation cost on the operating cost (OC) of the firm. Furthermore, it was observed that it is cheaper to transport per TEU unit of consignment from Germany to the shipyard by N1698840 than transporting from Japan. The t-score is 1682.02 and p-value of 0.000 at 0.05 alpha values. Since 0.05>0.000; it implies that the shipyard will achieve a significant reduction in annual transportation of this ship building and repair inventory type by sourcing from strictly from Germany if transportation cost remains the major or sole decision variable.

1.0 INTRODUCTION

Shipping is known as the nucleus of globalization. Dockyards which are the locations where shipbuilding and repairs take place are indispensable in the development strategies of global economies (Akasso, 2011; Alari, 2019). The shipbuilding and repairing industry is a foremost aspect of maritime activities and it is responsible for conception and design, construction and delivery cum maintenance and maintenance of vessels of diverse kinds for the conveyance of global seaborne import and export and other marine structures. Growth in demand for shipping in global markets has resulted to the emergence of bigger shipyards from the consolidation of several smaller and weaker shipyards. This has ultimately led to the development of shipbuilding clusters: in East Asia, Europe and the United States of America. These maritime clusters have created a demand niche for themselves; East Asia dominating the market for general cargo vessels, oil tankers and container ships, Europe leading in construction of luxury yachts, tugboats, cruise ships and ice breakers and USA dominating in building of naval ships (Akinlola, 2015). The place value of shipyards in the overall matrix of the global economy is better appreciated with knowledge of the contribution of shipping to global economy. For example, global container shipping throughput for 2020 was USD119.4billion; this was 2.27% less than the value for 2019 which was largely caused by the coronavirus (COVID-19) pandemic. The relevance of shipping is obviously evident in the fact that coastal nations which serve as shipping hubs have the most viable economies on the globe. A shipyard (or dockyard) is a facility set up for the building and repairing of all types and sizes of vessels such as oil tankers, container ships, RORO vessels, passenger ships, yachts, tugs, military vessels, submarines, special vessels and other marine structures.

Barney et al (2008) and Bertram (2003) agree with the Council of Logistics Management (2008), Logistics is that part of the supply chain process that plans, implements and control the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements. In an industry such as the shipbuilding and repair industry characterized with its global nature, a critical analysis of its logistics network is essential to give a competitive edge to the local industry in Nigeria. Strategic analysis of logistics network is designed to reduce cost, increase client service level and maximize profit. In the shipbuilding and repair industry, a logistic network analysis is usually employed to compare the different sources of supply, determine scheduling, weighing the options of producing the part in the yard or buying finished parts, warehousing and man-hours, among other areas. About fifty percent of the non-capital cost in shipbuilding is the cost of materials; the percentages being higher for larger shipyards as materials are purchased rather than being manufactured within the shipyard. Some advanced shipbuilding industries such as China's has evolved their logistics network to the level of intelligent inventory which is a concept that tends to zero inventory holding costs associated with shipyard operations(Perez-Labajos et al 2014; Akinlola, 2015). This practice has led to emergence of Asian shipyards as giants and global destinations for new building and repair of ships by ship-owners and operators.

In Nigeria, available local shipyards seem to have neglected the need to strategically implement the tenets of logistics, transport and inventory management by which logistics and inventory holdings costs of shipyards are optimized to the benefit of the industry. The goal being to reduce cost, optimize productivity, gain competitive edge and sustainable improve productivity. There are about ten (10) existing shipyards in Nigeria, only six are currently fully or partially operational (Nwokedi and Igboanusi, 2019). The problem is not with the number of dockyards in Nigeria; rather, the colossal problem is with the state of these dockyards as four of these dockyards are not operational and the other six are performing far below optimal capacity. However, there is several low capacity dockyards engaged involved in building boats and barges for inland and coastal shipping only. This study focuses on Starz marine Shipyard Onne, both in Rivers State to draw its inferences. The poor performance of Nigeria in the maritime and blue economy sector could rightly be associated with her inability to develop her shipbuilding and repair industry to a reasonable standard. The first step towards making local shipyards competitive should be to address the problems of high operational costs imposed by the logistics networks of the shipyards.

As a result sourcing, acquisition and use of majority of the input resources into shipbuilding building and repair are usually negatively influenced by paucity of funds and poor logistics management strategies. Thus foreign firms continue to dominate ship building and repair sector in Nigeria. One way which the shipbuilding industries in the developed world particularly in China, South Korea, America and Japan has overcome challenges of high cost of input acquisition for shipbuilding is the efficient and effective application of logistics and inventory management systems along the shipyards input and output supply networks. Over the years, these foreign shipyards have been able to drastically reduce the ship building and repair costs by limiting significantly for example, the cost of inbound logistics of delivery inputs to dockyards from Australia, New Zealand and other geo spatial locations with comparative advantage in supply of shipbuilding input resources. This is not the case with Nigeria where the cost of operations of the local shipyards remains high limiting their competitiveness. Thus, local operators in the industry seems not to have mastery of the logistics networks of the inbound logistics systems of the shipbuilding industry with the resultant effect of high operating cost and limitation of competitive capability. The study therefore seeks to analyze the transportation cost implications of the inbound logistics network of selected indigenous shipyards with a view to developing optimal inbound logistics networks/routes that will enable the shipyards to compete favorably with their foreign counterparts, at least in the repair and building of small water crafts for local use. The aim of this study therefore is to evaluate the transport cost implications imposed by the inbound logistics networks on the operations cost of the shipyards in order to improve the performance of the sector.

The specific objectives of the study include:

1. To identify the input materials types sourced from the inbound logistics networks that form the determinant inventory types maintained by the shipyard higher levels in the stock over the years.
2. To evaluate the annual transportation cost implications of shipping per unit load of inventory from the identified supply sources/inbound logistics networks.
3. To compare the transportation cost of shipping inventory from alternative/multiples sources on the inbound logistics network of the shipyard.

2.0 BRIEF REVIEW OF LITERATURE

Alari (2019) notes that there is a rational need for Nigerian government to strengthen and give support to the development and to the growth of the shipbuilding and repair industry because it is a core industry that can be of great assistance to the development of the economy. The Maritime Industry of Nigeria over the years, has grown according to the statistics shown on the evolution of fleet in Nigeria, as such a vibrant shipbuilding and repairing industry needs to be established to service this fleet. Hundreds of vessels operating around Africa and the Gulf of Guinea in particular sometimes have to travel far distances for servicing and repairs. Most times, the few operational shipyards in Nigeria are always fully booked. Nigeria has the competitive advantage of having those vessels serviced in her yards rather than traveling halfway across the globe just to be serviced. Ship technology forms the basis for competition and comparative cost advantage in shipping trade. Shipbuilding technology is the core of a maritime nation's freight earning capability for foreign trade (Ekieyaibo, O., 2018; Dettme 2000; Dye, 2019)

Akaso et al (2011) listed promotion of trade and commerce, generation of revenue, development of related economic activities, job creation, industrial growth, institutional development, international relations, and enhancement of national defense as some of the benefits accruable to the development of ship technology in Nigeria. An active shipbuilding and repairing industry for example can provide massive employment and boost the Gross Domestic Product (GDP) of a country. According to George (2015), in 2013, the U.S. private shipbuilding and repairing industry directly provided 110,390 jobs, $9.2 billion in labor income, and $10.7 billion in GDP. Including direct, indirect, and induced impacts, on a nationwide basis, total economic activity associated with the industry reached 399,420 jobs, $25.1 billion of labor income, and $37.3 billion in GDP in 2013. In Europe, ship building and repairing provides over 100,000 direct jobs for skilled manpower and generates 30 – 40 billion Euros annually (Mickeviciene, R., 2010; Uba, 2011).

China, South Korea and Japan, the best economies in the world seem to have an identical pattern for their rise to global influence – shipbuilding. Petermode (2014) ascribes shipbuilding and repairing as a major constituent of the maritime transport industry. Stressing on the relevance of the industry to the nation's economy, he reiterated the particular contributions in terms of job creation, cash flow circulation and foreign exchange. Arguably, the biggest economies in the world are shipbuilding nations. This is by no means trying to exaggerate the contribution of shipbuilding and repairing to GDP's; Canada is the only country in the 10 biggest economies of the world that is not one of the top 10 shipbuilding entities (Silver, 2020) shipbuilding is recognized as an important and strategic industry in the European union (Europa.edu). Shipbuilding is seen as a strategic industry due to its major due to its major contributions industrial and defense strategic industry (Kalouptsidi, M. 20220; Shin, K. & Ciccantell, P., 2009).

Management of material flow in shipyards could be quite tasking due to the complexity of the entire shipbuilding process. While shipyards may take advantage of economic order quantity (EOQ) material purchases and multi ship building contracts to reduce cost and ultimately increase profit; they must be aware of related costs associated with inefficient planning and scheduling, and changes to the original baseline during the time of the shipbuilding contract (Sarder et al, 2010). Efficient management of materials is a key factor to the improvement of shipyard productivity. Leading shipbuilding nations have structured their shipbuilding industries into large clusters: hundreds of shipyards forming a giant network. In Japan, there are about eight shipbuilding clusters with over 1,000 shipyards. About 264 of these shipyards are engaged in building vessels of 10,000GT and above (OECD, 2016). The shipbuilding cluster in South Korea is a sophisticated marine cluster, linking up its logistics network with the marine equipment industry and electronics. Activities in the value-chain are fragmented across different production units and include everything from design to post sales (OECD, 2015). Establishing a reliable supply chain for a shipyard is necessary to eliminate excessive cost due to delays in design, material procurement and payments. Supply chain is even more important; given that shipbuilding is shifting from the traditional slipway construction to modular construction. Procurement of parts and coordination of modules for final assembly hugely determines the efficiency of the entire system (Baroroh et al, 2020).

Solesvik (2011) posited that inter-firm cooperation has a great potential to increase the competitive advantage of shipbuilding companies. Such inter-firm cooperation proves advantageous for companies by exploiting economies of scale; neutralizing threats; managing risks; sharing costs; creating low-cost entry into and exits from new markets and industry segments; facilitating the development of technology standards; and managing uncertainties (Barney and Hesterly, 2008). Developing the leverage of strategic alliances, firms can enjoy cushioned effects of market collapses and benefit from other firms' resources during market recovery and booms.

Alari (2019) in a holistic view of the maritime industry recommended that government should strengthen and support the industry in policy implementations, development of manpower and development of business; asserting that the industry is a core one and can greatly impact the economy. Creation of assertive policies backed by effective implementation is a strongly recommended strategy by Osemwegie (2019) to see to the prosperity of the Nigerian maritime industry. A combination of innovation, new technology and skilled management is the formula for long term prosperity of the shipbuilding industry (Hossain, 2018). He also adds that industrialization is the precondition for development of national shipbuilding. Financial support, government involvement and cooperation among local shipyards are other significant factors in the improvement of national shipbuilding. According to Akinola B., (2015), a viable maritime industry and Nigeria-flag fleet is essential to the nation's economic and security interests. Given that shipbuilding and ship repairs is a core aspects of the maritime industry, national policies must cease to neglect; rather, integrate shipbuilding and repairing as a vital component of the transportation system.

As an entrant into the shipbuilding market, China started as a low cost builder; backed with government support, huge investments and cooperation with ship equipment manufacturers, their order book grew to the largest volume worldwide in 2010 (Mickeviene, 2019). Also, by consolidating its shipyards into two large conglomerates: China Shipbuilding Industry Corporation (CSIC) and China State Shipbuilding Corporation (CSSC), they recorded a growth of 43% and exported ships and boats to 159 countries in 2009 (ECORYS SCS group, 2010).

Hossain (2018) asserted that due to its multiplier effects, the shipbuilding industry is important and strategic. In comparison to South Korea which thrived in the 1970s on the hinges of lower labour cost, low currency value and favourable government policies; Nigeria, characterized by a weaker currency, low labour cost and a huge availability of industrial place-value deficit (plaguing the entire sub-Saharan region) could turn its local shipbuilding and ship repair industry to a regional hub.

Given the absence of sufficient local capacity since the implementation of the Cabotage Act, approximately 32,604,044 USD was lost to foreign vessel owners and operators between 2004 and 2013. Consequently, huge revenue could be won back to the economy by local investors if the shipbuilding capacity is raised to provide sufficient tonnage for inland and coastal trade. (Nwokedi & Igboanusi, 2019)

Hassan, et al (2017) identified shipbuilding as an opportunity that can grow into a billion-dollar industry in a single decade. Placing Nigeria on a scale with other thriving players on the global stage like Singapore, Bangladesh and Vietnam; Nigeria has a comparative advantage (at least regionally) in terms of length of coastline, labour cost and currency value to attract foreign direct investment in shipbuilding and repairs. Whereas the global shipbuilding, repair, conversion and demolition market is highly competitive with no less than 5,076 registered shipyards; vessel orders for dry bulk, container, wet bulk and general cargo vessels have remained static and an increased demand for short sea shipping favours closer yards over distant docks (Dyer, 2019; Neven *et al*, 2018).

The availability of labour, arguably inadequate can be tapped in by training the unskilled labour with sufficient technical know-how for various operations. The weakness militating against the industry does not quite challenge the opportunities can infrastructures can be upgraded and technology updated to give it sufficient competitive advantage.

3.0 DATA AND METHODS

This study employed the mixed research design method in achieving the objectives of the study. It employed survey design in which questionnaire was used as survey instrument to elicit the responses of the operational staff of the shipyard on what constitute the key input materials to the ship building and repair processes in the shipyard for which they maintain inventory. The major source of each identified shipyard inventory type was also identified. It also employed the ex-post facto research design in which secondary data was obtained from the historical records maintained by the shipyard on input materials/inventory ordered over the years.

The study however employed the Starz Shipyard in Onne Port Harcourt as a case approach towards understanding the inbound logistics networks of shipyards in Nigeria and cost implications of each identified inbound logistics network on the operations cost of the ship building and repair sector in Nigeria .

3.3 Study Population

The population of the study consists of the about 115 operational staff who work in the dock and materials management and procurement sections of the company. From this population, samples were randomly selected and the survey instrument delivered to each respondent for responses. For the purpose of conducting the survey, the study adopted a purposive random sampling technique in which the responses of workers in the operations, materials management and procurement section of Starz marine shipyard were purposively randomly sampled. The reason for the purposive random sampling was because these employees were the ones that are directly involved in the procurement, handling and storage and well as use of the materials and various inventory types in the shipyard.

3.4 Sample Size

The sample size was determined by the use of Taro Yammane formula for determination of sample for known population that:

$$n = \frac{N}{1 + N(e)^{2})}$$

Where：
n= sample size required
N = number of people in the population
e = allowable error (%) = 0.05
n = 88

The sample size consists of 88 employees in operational, materials management and procurement section of the shipyard randomly sampled.

88 survey instrument/questionnaires were distributed. However, 66 of the questionnaires representing about 75% of the distributed questionnaires were properly filled and returned and used in the analysis.

3.1 Method of Data Analysis

The study employed various methods to analyze the data collected. It used the principal component (PCA) method to determine what input material types constitute the principal component materials for which the shipyard maintains as inventory in the stock yard/warehouse. The study also employed the modified network analysis method to present the various sources of the input materials to shipyards and the associated cost of transporting per TEU from the sources to the shipyard. The difference of mean statistical tool was used to compare the transportation cost implications of sourcing input materials from alternative locations/sources, transportation cost, average number of orders per annum relationship analysis was used to determine the annual transportation cost implications of delivering the input materials from various sources/locations on the operations cost of the shipyard per annum . Finally, trend analysis was used to estimate the ordering trend of each ship building and repair input material types per annul between 2015 and 2019.

3.1.1 Difference of Means Method

The data collected was also analyzed using the difference of means test to estimate the existence of significant differences between the transportation costs of delivery per unit load of input material types sourced from multiple locations (more than one source) to the shipyard. For example, the transportation cost of transporting per TEU of marine diesel engines and components sourced from both Japan (Asia) and Germany (EU) was compared for significant differences using the different of means statistical tool. For objectives three which seeks to compare the transportation cost of delivery per unit load of input resources sourced from multiple locations in the logistics network was achieved by the use of the difference of means statistical tool.

The formula is given below:

Difference of mean $X_{diff} = \sqrt{\frac{\bar{x}_f - \bar{x}_l}{\frac{S_f^2}{n_f} + \frac{S_l^2}{n_l}}}$

Where t= t-statistics results for the difference of means

$\bar{x}_f$ = mean of transportation cost of delivering per unit load of a given input material (A) from location X_f on the logistics network
$\bar{x}_l$ = Mean of transpiration cost of delivering per unit load of a given input material (A) from location x_L on the logistics network
S_f^2 = Variance of individual parameter readings for X_f
S_l^2 = Variance of parameter estimates for X_L
n_f = n_l = = N = Samples sizes

An independent sample T-test may equally be used to estimate the significances of the differences in the transportation costs of delivering per TEU from multiple sources. The formula for the T-Test is shown below:

$$T = \frac{XT - XC}{\sqrt{\frac{VarT}{NT} + \frac{Varc}{Nc}}}$$

3.1.2 Transportation-Cost Average-Annual-Orders Relationship Analysis (TARA)

The TARA was used to estimate the annual transportation cost effects of delivering the input material types from the various sources on the operations cost of the shipyard. It is observed that the annual cost of transportation (*TC_a*) of each input material type from the sources (logistics networks) to the shipyard in Nigeria is a function of the average orders (AO_a) of each input material per annum and the transportation cost of per TEU/unit load (TC_u) from each logistics network to the shipyard in Nigeria. The aggregation of the transportation costs from all the logistics networks (sources of the inputs) per annum gives the cumulative transport cost implications of the entire inbound logistics network on the annual operations cost (OC_a) of the shipyard. Thus for each source of input material, the annual transportation cost borne for delivering all order each year is given as:

$$TC_a = (AO_a (TC_u) /1)$$

Using the above equation, we achieved the third objective of the study and estimated the annual transportation cost (TC_a) of delivering per unit of input materials from each logistics network (source) to the shipyard.

The aggregate transport cost implications of the entire sourcing from the entire logistics network per annum on the operations cost of the shipyard is obtained by using the formula below for a total network from 1 , 2, 3, ------------ n:

$$TC_{a(1-n)} = (TC_{a1} + TC_{a2} + TC_{a3} \quad --------- \quad + TC_{an})$$

Where:

$TC_{a(1-n)}$ = The aggregate transport cost implications of the entire sourcing from the entire logistics network per annum on the operations cost of the shipyard is obtained by using the formula below for a total logistics network from 1 to n
TC_{a1} = Total annual transportation cost imposed by logistics network one (1)
TC_{a2} = Total annual transportation cost imposed by logistics network two (2)
TC_{a3} = Total annual transportation cost imposed by logistics network three (3)
n = number of logistics networks.

4.0 RESULTS AND DISCUSSION OF FINDINGS

Table 1: Determinant Shipyard input Material/inventory Types

	Mean	Std. Deviation	Analysis N
MDEC	.9394	.24043	66
EENSC	.8636	.34580	66
PSSC	.6818	.46934	66
BPTM	.3788	.48880	66
SPP	.4848	.50360	66
SAHPM	.6818	.46934	66
MPBC	.8182	.38865	66
MFPF	.3788	.48880	66

Communalities

	Initial	Extraction
MDEC	1.000	.824
EENSC	1.000	.816
PSSC	1.000	.700
BPTM	1.000	.904
SPP	1.000	.822
SAHPM	1.000	.795
MPBC	1.000	.874
MFPF	1.000	.904

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.840	47.995	47.995	3.840	47.995	47.995
2	1.568	19.597	67.593	1.568	19.597	67.593
3	1.230	15.379	82.972	1.230	15.379	82.972
4	.614	7.675	90.647			
5	.324	4.055	94.702			
6	.255	3.186	97.888			
7	.169	2.112	100.000			
8	3.989E-020	4.986E-019	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component		
	1	2	3
MDEC	.253	.863	.127
EENSC	.357	.823	.103
PSSC	.487	-.188	.653
BPTM	.911	-.196	.189
SPP	.898	-.127	.005
SAHPM	.788	.114	-.401
MPBC	.570	-.067	-.738
MFPF	.911	-.196	.189

Extraction method: Principal Component Analysis
Source: Author's calculation

The result of the Principal Component Analysis (PCA) shown in Table1 above shows the principal component input material types sourced from the various inbound logistics networks of the shipyard. The aim is to provide scientific evidence of which input material types constitute the major component input materials that the shipyard maintains higher levels of inventory for in the warehouse/store, given the transportation cost, distance of the supply points and the need to avoid stock-out situations of such input material types by the shipyard. It is obviously important the distance of the supply sources, the cost of delivering the inventory and the need to either shoulder of avoid inventory carrying/warehousing costs will influence the logistics strategy of the firms with regards to the levels and quantity of each type of input material that will maintained and/or stocked in the store the firm. This will in turn influence the re-order point and annual order frequency of the individual inventory types. Thus the result of the PCA indicates that mean scores of various categories of input materials/inventories of the firm which include marine diesel engines & components (MDEC), electrical electronic navigation system & components (EENSC), propulsion shafting system component (PSSC), bearings, piping & tubing materials (BPTM), sandblasting, marine paints &pigment (SPP), steel & aluminum hull plating materials (SAHPM), other mechanical parts, boilers & components and mooring-lines, furniture, plastic fittings & decorative (MFPF) is 0.9394, 0.8636, 0.6818, 0.3788, 0.4848, 0.6818, 0.8182 and 0.3788 respectively.

The PCA also indicate that about three (3) input materials/inventory types with Eigen values greater than or equal to 1 are the significant component inventory types which the shipyard need to maintain higher inventories of in the store in order to limit inventory carrying cost and adopt a favourable logistics and materials management strategy. Marine diesel engines components (MDEC), electrical electronic navigation systems components (EENSC) and other mechanical parts, boiler mountings components (MPBC); each with respective Eigen values of 3.840, 1.568 and 1.230. Since each has respective Eigen value greater than 0ne (Eigen value>1), we conclude that they are the principal component inventory types significantly maintained by the firm in higher proportions in the inbound logistics materials stock of the firm in the store. The transportation cost effects of the decision to maintain the above identified input stock as the principal inventories of the firm influenced by the sources of supply of each inventory class in the logistics network of the firm is examined in subsequent sections of this work.

Table 2: Annual Transportation Costs of Delivering per Unit Load of Inventory/ Input materials from each Supply Location/Source and the implications on the Annual Operating Cost of the Shipyard

s/n	Shipyard inventory/input materials type(s)	Supply Source(s)	Average number of orders per annum= (AO_a)	TEU/unit load shipping cost per order (₦) (TC_u)	Annual shipping cost (₦) TC_a
1	Propulsion shafting system &Components (PSSC)	EU, Germany	4.4	877500	3861000
		Japan		1263600	5559840
					Ave.:4710420
2	Other Mechanical parts, Boiler mountings & components (MPBC)	EU, Germany	4.8	877500	4212000
3	Marine diesel engine & components (MDEC)	Asia, Japan	4.8	1263600	6065280
		Germany, EU		877500	4212000
					Ave:5138640
4	Bearings, piping &Tubing materials (BPTM)	Locally, Nigeria	6.4	400000	2560000
5	Sandblasting, marine paints and pigment materials (SPP)	Asia, China	5.6	588672	3296563.2
		Nigeria		400,000	2240000
					Ave.: 2768281.6
6	Electrical, electronics, navigation systems &components (EENSC)	U.S.A.	4.8	1365000	6552000
		Japan		1263600	6065280
					Ave. 6308640
7	Structural steel, Aluminum hull plating materials (SAHPM)	Asia, China	4.8	588672	2825625.6
8	Mooring lines, furniture, plastic fitting and decorative materials (MFPF)	Locally(Nigeria)	6.2	400,000	2480000
Sum=	₦$TC_{a(1-n)}$		41.8		31,003,607.2

Source: Author's calculation

The result of the findings as shown in table.2 indicates the total annual transportation cost borne by the shipyard in conveying each input material/inventory type from the various supply sources depicting the inbound logistics network of the shipyard as a relationship between the average number of orders (frequency of orders) of each inventory type per year and the cost of transporting per unit load (TEU or truck load) of each identified inventory type between 2015 and 2019. The result indicates that a total sum of ₦31, 003,607.2 was borne by the shipyard as annual transportation cost of delivery per unit load of orders of all the input materials/inventory types. The implication is that the operating cost (OC) of the shipyard is increased by 31,003,607.2 naira each year between 2015 and 2019 as a result of the cost of transportation of various input material/inventory types from the various inbound logistics networks of the firms depicting the raw materials supply locations. By implication, an aggregate sum of ₦155018036 was spent as transportation cost of delivery input/inventory materials from all the inbound logistics networks and/or supply locations to the shipyard in Nigeria.

The result also shows that the annual cost of transporting per unit load of propulsion shafting systems & components with average order frequency of 4.4 per annum from Germany and Japan is ₦3861000 and ₦5559810 respectively; corresponding to an annual average of ₦4710420. The annual cost of transporting per unit load of marine diesel engines & components from Japan and Germany to by the shipyard with average order frequency of 4.8 per annum is ₦6065280 and ₦4212000 respectively; corresponding to an average transportation cost of ₦5138640. For electrical electronic navigation systems & components (EENSC), the average annual cost of delivering per TEU to the shipyard from U.S.A. and Japan in average order frequency of 4.8 times per annum is ₦6308640 while the annual transportation cost of delivering sandblasting, marine paints & pigments from China and Nigeria to the shipyard in average annual order frequency 5.6 times is an average of ₦2768281.6

Similarly, the annual transportation costs borne by the shipyard in delivering unit loads of MPBC, from Germany, MPTM from local sources, SAHPM from China and MFPF from local sources with respective average order frequencies of 4.8, 6.4, 4.8, and 6.2 are ₦4212000, ₦2560000, ₦2825626.6 and ₦2480000. It is observed that the inventory items which have less average annual order frequencies such as PSSC, EENSC, each with average order frequency of 4.4 and 4.8 respectively, etc imposed the greatest annual transportation cost while those with higher annual order frequencies such as MFPF, BPTM with respective average order frequencies of 6.2 and 6.2, etc imposed the least annual transportation cost on the operating cost (*OC*) of the firm.

The pie chart below summarizes the aggregate transportation cost burdens imposed by delivering ship building and repair inventory types from the identified inbound logistics networks of the shipyard.

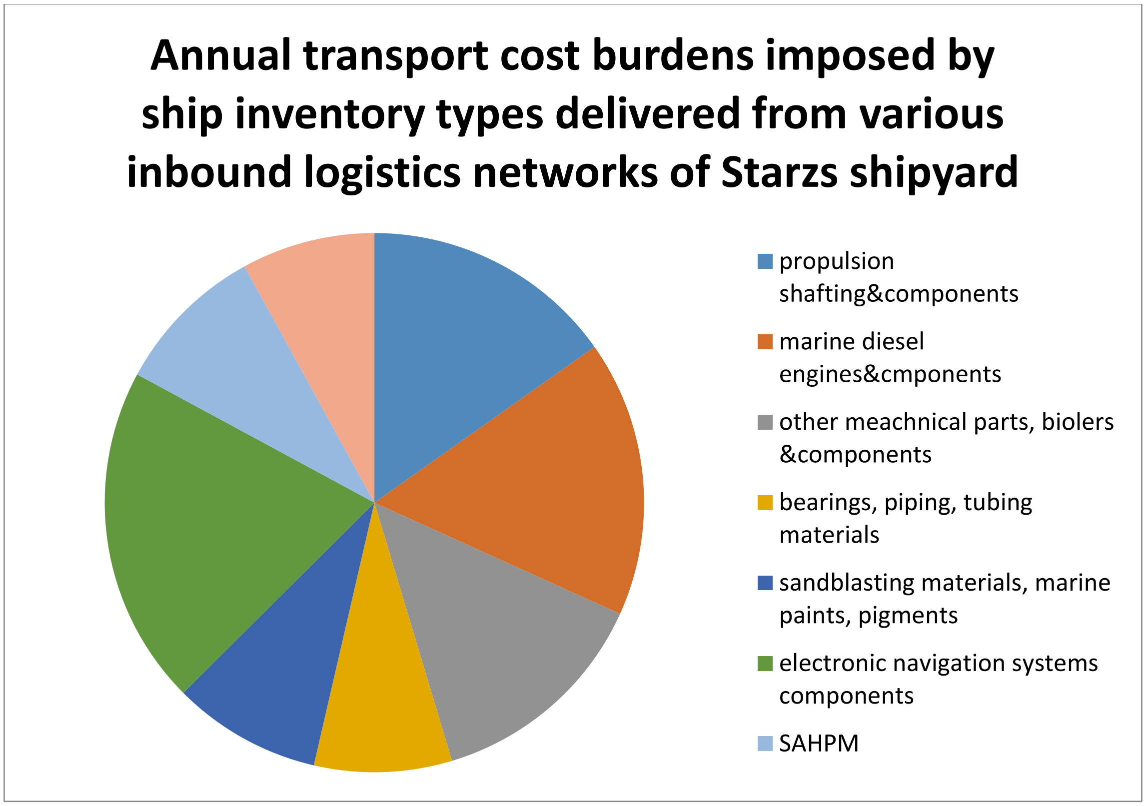

Fig. 4.2 Chart showing annual transport cost of inbound inventory of Starz shipyard
Source: Author's calculation

Table 3 Comparing the Annual Transportation Cost Burdens Imposed By Alternative Shipbuilding and Repair Inventory Supply Locations on the Operating Cost of the Firm

Inventory type	Alternate sources	Mean diff. in TC_a	Std. Deviation	t	Sig. (2-tailed)
Propulsion shafting systems & components (PSSC)	JAPAN - GERMANY	1698840.00000	1428.35570	1682.020	.000
Marine diesel engines parts &components (MDEC)	JAPAN - GERMANY	1853280.00000	14013.4315	1834.931	000
Sandblasting, marine paints &pigments (SPP)	CHINA - NIGERIA	1056563.20000	14140.57999	105.668	.006
Electronic navigation syst. & components (EENSC)	USA - JAPAN	486720.00000	1428.35570	481.901	.001

Source: Author's calculation

Recall that propulsion shafting systems and components (PSSC) is sourced by the shipyard from multiple (alternative) locations in Japan and Germany. A comparison of the transportation implications of delivery per unit load of this input material type from Japan and Germany per annum, given the average annual order frequency shows a mean difference of ₦1698840.00 with standard deviation of 1428.355. This indicates that it is cheaper to transport per TEU unit of consignment from Germany to the shipyard by ₦1698840 than transporting from Japan. The t-score is 1682.02 and p-value of 0.000 at 0.05 alpha values. Since 0.05>0.000; it implies that the shipyard will achieve a significant reduction in annual transportation of this ship building and repair inventory type by sourcing from strictly from Germany if transportation cost remains the major or sole decision variable.

Recall also that marine diesel engine parts and components (MDEC) are sourced from Japan and Germany with varying annual transportation costs from each supply source. A comparison of the transportation cost implications of sourcing this ship inventory type from the locations relative to the average order frequency of MDEC per annum shows a mean difference of ₦1853280.000 with a standard deviation of 14013.43. This implies that the shipyard will achieve a significant reduction in transportation cost of taken delivery unit loads of MDEC inventory types if it sources it solely from Germany. Sourcing from Japan imposes a higher burden of transportation cost per TEU unit load. Thus, assuming cost of transportation to be the major or sole decision variable for choice of source of supply of marine diesel engines and the associated components, it is best to source it from Germany as that yields significant reduction in transportation cost.

Similarly, the mean difference in the transportation cost between sourcing sandblasting, marine paints &pigment materials from China and sourcing same locally from Nigeria is ₦1056563.20 with standard deviation of14140.57. The t-score is 105668 and the p-value is 0.006 at 0.05 level of significance (alpha-value). This implies that there is a significant difference between the transportation cost of delivering per unit load of sandblasting, marine paints & pigments to the shipyards when supplied from China and Nigeria. It is best to sourced and deliver this inventory type from locally sources as it will enable the shipyard to achieve significant reduction in transportation cost of the consignment. The transportation cost will be reduced by ₦1056563.20 when sourced from local sources than from China.

Lastly, the shipyard with achieve a significant reduction in annual transportation cost of electronic navigational systems & components if that inventory type is sourced and supplied from Japan-Asia.

The bar chart below is an illustration of comparing the annual transportation cost of supplying unit loads of the various identified inventory types from multiple alternative sources.

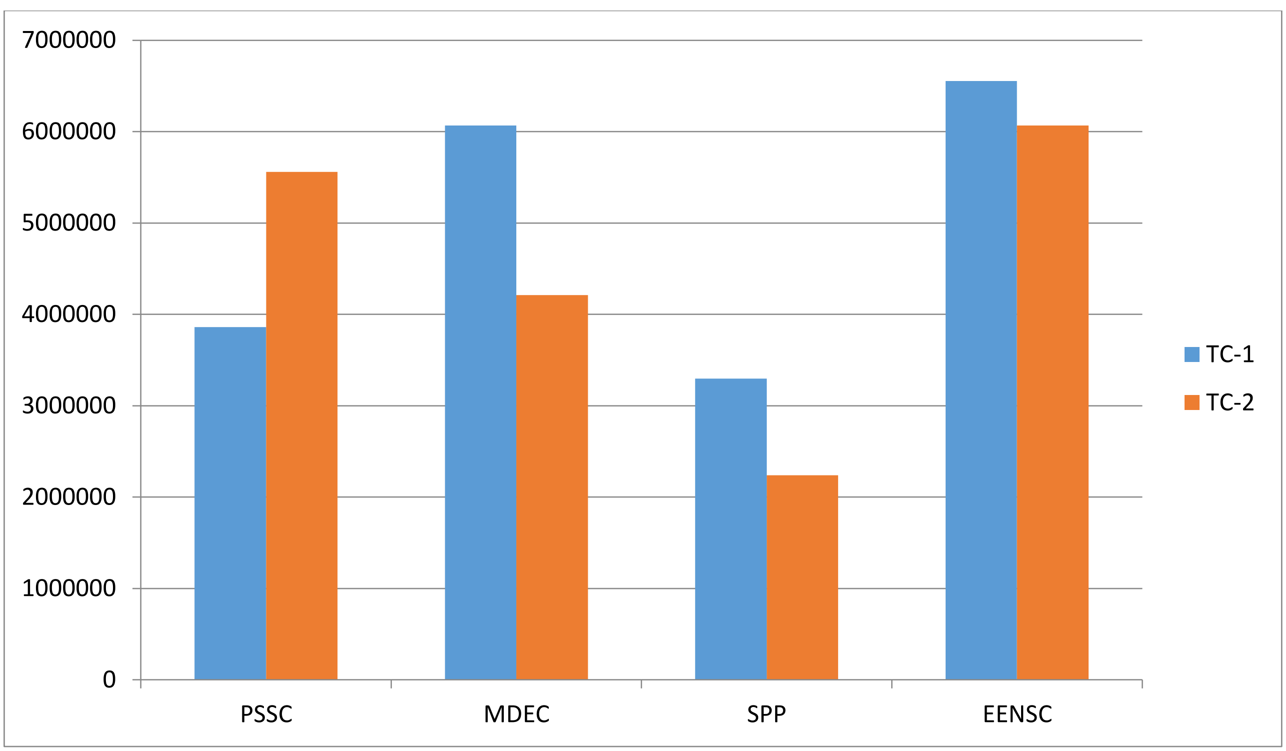

Figure 4.3: bar chart below is an illustration of comparing the annual transportation cost of supplying unit loads of the various identified inventory types from multiple alternative sources.

Source: prepared by the author.

Table 4: Annual Transportation Costs of Delivering per Unit Load of Inventory/ Input materials from each Supply Location/Source and the implications on the Annual Operating Cost of the Shipyard

s/n	Shipyard inventory/input materials type(s)	Supply Source(s)	Re-order points (months)	Annual shipping cost (₦) TC_a
1	Propulsion shafting system &Components (PSSC)	EU, Germany	3 months	3861000
		Japan		5559840
				Ave.:4710420
2	Other Mechanical parts, Boiler mountings & components (MPBC)	EU, Germany	3 months	4212000
3	Marine diesel engine & components (MDEC)	Asia, Japan	3 months	6065280
		Germany, EU		4212000
				Ave:5138640
4	Bearings, piping &Tubing materials (BPTM)	Locally, Nigeria	2 months	2560000
5	Sandblasting, marine paints and pigment materials (SPP)	Asia, China	2 months	3296563.2
		Nigeria		2240000
				Ave.: 2768281.6
6	Electrical, electronics, navigation systems &components (EENSC)	U.S.A.	3 months	6552000
		Japan		6065280
				Ave. 6308640
7	Structural steel, Aluminum hull plating materials (SAHPM)	Asia, China	3 months	2825625.6
8	Mooring lines, furniture, plastic fitting and decorative materials (MFPF)	Locally(Nigeria)	2 months	2480000

Source: Prepared by Author

It is evident from the table above that the sourcing strategy of the shipyard support the stocking in the warehouse of higher volumes of input materials from logistics networks and supply points that impose higher transportation costs on the company in order that a higher re-order points of 3 months be reached before such inventories are re-ordered. As the same time, input materials from logistics networks and sources with impose less transportation cost burdens on the firm are maintained lesser in the warehouse stocks to achieve an lower re-order points.

5.1 CONCLUSION

In conclusion, the overall total cost of transporting unit loads of inventory via the inbound logistics networks of the shipyard representing the inventory supply points have influence on the annual operating cost of the firm. This in turn affects the profitability performance of the firms and may have consequences on her viability and operational sustainability at the long-run. Thus necessitating the need for the analysis of the influence of the transportation cost imposed by each supply source on the logistics network on the operations cost of the firm.

The study in this regard has been able to determine that transporting unit loads of all the identified inventory types from the identified supply sources representing the inbound logistics network of the firm imposes an annual transportation cost of ₦31,003607.6. It was also found that the firm will achieve a significant reduction in transportation cost of taken delivery of unit loads of MDEC inventory types if it sources it solely from Germany. Sourcing from Japan imposes a higher burden of transportation cost per TEU unit load. Thus, assuming cost of transportation to be the major or sole decision variable for choice of source of supply of marine diesel engines and the associated components, it is best to source it from Germany as that yields significant reduction in transportation cost.

Similarly, the mean difference in the transportation cost between sourcing sandblasting, marine paints &pigment materials from China and sourcing same locally from Nigeria is ₦1056563.20 with standard deviation of14140.57. The t-score is 105668 and the p-value is 0.006 at 0.05 level of significance (alpha-value). This implies that there is a significant difference between the transportation cost of delivering per unit load of sandblasting, marine paints & pigments to the shipyards when supplied from China and Nigeria. It is best to sourced and deliver this inventory type from locally sources as it will enable the shipyard to achieve significant reduction in transportation cost of the consignment. The transportation cost will be reduced by ₦1056563.20 when sourced from local sources than from China. Furthermore, the shipyard with achieve a significant reduction in annual transportation cost of electronic navigational systems & components if that inventory type is sourced and supplied from Japan-Asia.

It is evident from the result of the study that transportation cost effects of sourcing from the identified supply points on the inbound logistics network of the firm influences her inventory management strategy with regards to avoiding carrying costs for some inventory items and shouldering carrying cost from some. It also influenced the re-order points and annual order frequency of inventory types used by the firm.

5.2 Recommendations

It is recommended that:

(1) The shipyard should strive to achieve a reduction in the cost of operation by considering achieving a reduction in aggregate annual cost of transportation of inventory from the various sources that offers reduced cost of transportation to the shipyard. This it can achieve by considering first, the inventory sources on the logistics network that puts the less transportation cost burden on the firm.
(2) Local alternative sources of supply of inventory types such as sandblasting, painting & pigment materials should be developed by the shipyard as this will reduce the cost of sourcing inventory from overseas as well as support the local content development initiative of government.

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